

Restoration of sustainability of physically degraded fish habitats – The Model of Intermediate Restoration.

Maciej Zalewski, Robin Welcomme

Abstract

The Restoration Ecohydrology Concept integrates two approaches to restoration and mitigation of physically modified freshwater habitats. Firstly actions at the catchment level connected with integrated management of abiotic factors including, landscape planning, catchment management, forestation, phytotechnologies and hydrology by impoundment. Secondly actions at the level of the aquatic ecosystem itself, particularly those linked to fisheries management. The highest biodiversity and productivity of fish assemblages appears at an intermediate level of human disturbances, which, in the case of the biogeochemical cycle, has usually been connected with limited degradation of catchment cover. The increase of fish biomass and diversity under these conditions apparently results firstly from nutrient enrichment and improved energy influxes to the stream arising from the more rapid cycling of nutrients of terrestrial origin cycling, and secondly from the intermediate complexity of the riparian ecotones. The maximum of biomass might appear under different conditions than those that favour maximum biodiversity due to this ecosystem enrichment and amplified access to energy. The data presented at the symposium lead to following conclusions:

1. Restoration of river systems to pristine conditions is not realistic but is also not necessary.
2. The target of restoration of physically degraded habitats should lie somewhere in the range between maximum biodiversity and maximum productivity of fish communities.

Key words: ecohydrology, river basin, fish communities, biodiversity, productivity, human impact

Ecological models are useful tools in ecohydrology

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Abstract

Ecohydrology presumes that physical external variables have a major influence on the biological components of an ecosystem and vice versa. The relationships between physical factors and biological components may be useful tools in environmental management. It requires, however, that these relationships are known quantitatively. It is only possible through the development of a proper model for the ecosystem, because of the high complexity of the ecological network involved. A "proper model" is a model that can account for changes in species composition and adaptation, when the prevailing conditions are changed, i.e., a structurally dynamic model. The paper presents a model, that shows how a change from a constant out-flow rate from a reservoir to an out-flow rate that is purposely higher at the time of spring and summer bloom and at the time of spawning for planktivorous fish, is able to reduce the eutrophication level. The model presented in this paper considers only the phosphorus cycle, because phosphorus is presumed to be the limiting nutrient for phytoplankton growth. Two more ecohydrological examples that could be used quantitatively by use of a proper model are mentioned. The conclusion is, that ecohydrology offers possible and appropriate environmental management solutions but that a proper model for the considered cases is required to utilise ecohydrological possibilities quantitatively.

Key words: Structurally dynamic models, ecological models, environmental management, ecohydrology.

Impacts of man's modifications of river hydrology on the migration of freshwater fishes: a mechanistic perspective

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Abstract

Over the past centuries, rivers and streams across Europe and Northern America have increasingly been modified by damming and by other water regulation schemes. This situation is also becoming increasingly common throughout tropical regions. In the vast majority of cases, such schemes have been developed with little or no consideration to the ichthyofauna, and impacts on biodiversity and fisheries have been and still are numerous. Here we provide an overview of how anthropogenic modifications of river systems, resulting in hydrological changes, also impact on fish migration, focusing on the environmental stimuli triggering or enhancing migratory behaviour, the energetics of migration and their variations between species and life styles. This overview concentrates on European freshwater fish species and case studies, but also includes examples from other geographical areas, as the problem tackled here is worldwide. Well-documented long-term case studies of the influences of hydrological changes on fish migration, from the peer-reviewed literature, are still greatly outnumbered by past, present or planned schemes. Additionally, there are many aspects of fish biology, such as spatial ecology, which remain poorly known or understood, yet such knowledge is fundamental to an ecologically sensitive approach to integrated river- and fisheries management.

Key words: life history, diadromy, potamodromy, regulated rivers, biodiversity

Stream habitat or water quality - what influences stronger fish and macrozoobenthos biodiversity?

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Abstract

The data obtained within the framework of a survey of macrozoobenthos and fish communities in Czech streams of the Danube and Elbe river basins were evaluated with respect to the relation between biodiversity and level of water (organic pollution) and/or physical habitat quality (heterogeneity, substrate, riparian vegetation, canalisation). The diversity of macrozoobenthos species was the highest at the water quality corresponding to betamesosaprobity (saprobiological index $SI \approx 2,0$) and oligosaprobity ($SI \approx 1,0$) in lowland and highland streams respectively, declining both towards lower and higher saprobic (\approx trophic) levels. The response of macrozoobenthos to habitat quality deterioration was less considerable with rising degradation in highland streams than in lowland ones. Fish assemblage followed a similar trend, namely: the highest biodiversity in betamezosaprobity in both lowland and highland streams. In comparison with the assemblage of benthic macroinvertebrates, fish community response was more pronounced both regarding water quality and habitat degradation. Both fish and macrozoobenthos biodiversity were influenced more by water quality than by physical habitat degradation.

Key words: stream ecology, water quality, habitat quality, macroinvertebrates, fish community, Czech Republic

Some considerations of the effects of differences in flood patterns on fish populations

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Abstract

Fish are heavily influenced by the nature of the flood regimes of the rivers in which they live. These fluctuate naturally from year to year but recently increasing pressure on water for a wide range of uses other than fisheries has led to human activities that have substantially altered the flood regimes of many rivers throughout the world. This has resulted in the loss of fish production and biodiversity. There are now efforts to mitigate for these changes that include release of artificial floods from dams or polder sluices. The typical flood curve contains several characteristics that may influence the survival and growth of the individual fish species. Understanding of these characteristics will help design appropriate flood curves and maximize benefits from the water available.

Key Words: Fisheries, Floods, Rivers, Rehabilitation

A Dynamic Pool Model for Floodplain-River Fisheries

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Abstract

This paper describes a deterministic age-structured dynamic pool model for floodplain-river fisheries. The model is applied to a heavily exploited floodplain fishery in north west Bangladesh to quantify the effects of hydrological modification and exploitation on production (catch per unit area) inside a typical flood control scheme, and to explore mitigating management interventions. Existing modifications to the hydrological regime were predicted to diminish production only marginally (10%), and similar differences in production may result from differences in the seasonal pattern of exploitation. Closing the fishery for a month was predicted to increase production by at least 30%, with greatest increases (up to 115%) predicted for closures during those months when fishing mortality is at its highest. The practicability of fishing strategies that maximise production are discussed. The model also predicts that diminished production caused by modifying flood season water heights inside flood control schemes may be compensated by increasing dry season water levels. Manipulating water levels in this way by means of sluice gates must, however, take account of the often conflicting needs of other sectors such as agriculture, and the importance of dynamic edge effects for maintaining the natural fertility of the floodplain. Sensitivity analysis indicates that more reliable model predictions may be achieved with more precise estimates of the parameters which affect recruitment.

Keywords: Floodplain fisheries, hydraulic engineering, simulation model, Bangladesh

Effects of alterations in freshwater supply on the abundance and distribution of *Engraulis encrasicolus* in the Guadiana estuary and adjacent coastal areas of south Portugal

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Abstract

A reduction of inflow to the Guadiana River on the border between Portugal and Spain may directly contribute to the degradation of fish habitats. Changes are expected to the spawning behaviour of *Engraulis encrasicolus* adults, to the migration patterns of larvae in the estuary, and to the catches of fisheries in the lower part of the river and adjacent coastal areas. Spawning of *E. encrasicolus* occurs in the lower part of the estuary and in the adjacent coastal areas. However, high abundances of larvae have been registered in the middle and upper parts of the estuary, the most productive region of the estuary, that with the estuarine turbidity maximum (ETM). In a year of normal inflow, such as the hydrologic year 1987–1988, some retention of larvae occurred in this area. However, in an abnormal hydrologic year with a low inflow (1999–2000), and with an increase in freshwater inflow during the spring months, a disturbance to the migration pattern seems to have affected the survival of larvae in the estuary. High river inflow, probably associated with an increased input of nutrients, appears to have an important and positive effect on adult numbers, because anchovy fishery catches in the adjacent coastal area increased under these conditions.

Key words: Inflow variability, fish eggs, larvae and adults, habitat changes, Anchovy, *Engraulis encrasicolus*.

Importance of lentic waterbodies as fish nurseries in the flood plain of the Dyje River, Czech Republic

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Abstract

The occurrence of 0+ juvenile fish was observed using a point abundance sampling strategy in non-flooded borrow pits, flooded borrow pits, oxbows and backwaters in the flood plain of the River Dyje in August 1998 and 1999. The season of 1998 was characterized by a short-time managed flooding compared to a long-time managed flooding in 1999. Totally we registered the occurrence of 19 species of 0+ juvenile fish. The most abundant species were *Scardinius erythrophthalmus*, *Perca fluviatilis*, *Rhodeus sericeus*, *Rutilus rutilus*, *Blicca bjoerkna* and *Alburnus alburnus*. In the two years the composition and abundance of 0+ fish communities differed, especially in flooded borrow pits. A significantly higher species richness was found in both years in backwaters and flooded borrow pits compared to species richness in borrow pits and oxbows. The highest Catch per unit effort (CPUE) of 0+ fish was in the flooded borrow pits while the lowest CPUE was in non-flooded borrow pits. The duration of borrow pit flooding affected 0+ recruitment. In 1998, after short-time flooding, survival of 0+ fish was affected by predation of *P. fluviatilis* and high infection of metacercariae of *Posthodiplostomum cuticola*.

Key words: oxbows, borrow pits, 0+ juvenile fish, man-made habitat, restoration, Danube basin

The influence of littoral zone type and presence of YOY pike (*Esox lucius* L.) on growth and behaviour of YOY pikeperch, *Stizostedion lucioperca* (L.) – consequences for water quality in lowland reservoirs.

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Abstract

The influence of littoral type at presence and absence of young of the year (YOY) pike (*Esox lucius* L.) on growth and diurnal behaviour of YOY pikeperch *Stizostedion lucioperca* (L.) was investigated in triplicate (7.5 m²) field enclosures. Three types of littoral zone were applied: with homogeneous macrophytes (HOM), with heterogeneous macrophytes (HEM) and with woody debris (WD), together with control enclosure—without any structure (C). The type of littoral zone influenced the growth rate and behaviour of YOY pikeperch. The growth rates of small (<60mm) pikeperch were significantly higher in HOM than in controls, HEM and WD types of littoral. Similar but weaker relationships were found for larger pikeperch (>60mm) with their growth rates higher in HOM than in HEM and WD littoral types. At the presence of pike, the highest pikeperch growth rate was still noted in HOM, compared to WD enclosures. The results of pikeperch diurnal behaviour showed high littoral use at absence of pike (on average: 38% for C, 62% for HOM, 55% for WD, and 30% for HEM enclosures). Pikeperch utilised littoral habitat much less at presence of pike (15% for C, 8% for HOM, 3% for WD, 6% for HEM enclosures). On the basis of experiments it can be concluded that pikeperch growth rate and behaviour may be strongly affected by diversified littoral zones and by the presence of pike competition. Observed relationships may be applied for water quality control in reservoir. As a strong pikeperch population, achieved by enhancement of its growth through creation of most preferred nursery habitat (HEM), may enable to reduce zooplanktivorous fish community even in the presence of pike competition.

Key words: littoral complexity, prey-predator interaction, habitat selection, YOY fish: pikeperch, pike, roach.

The technology for reduction of fishes suffocation during winter period on example of Dnieper reservoirs

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Abstract

The two ways of modification the oxygen conditions of dam reservoirs in order to protect fish from suffocation at freezing periods were presented: 1) the ice-hole size enlargement, and 2) short-term rises of a water level to raise oxygen concentration in the waters in fishes wintering sites. Both the methods are based on the modifications of the water flow through hydroelectric power stations as the only management tool. The mathematical formulae for calculating water flows and its effects are presented, as well as examples of calculation for January and February for Kremenchuk Reservoir (Dnieper River).

Key words: ice cover, oxygen concentration, water regime, dam reservoir,

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Abstract

Deteriorating environmental conditions and overexploitation in situations of insufficient fish stocking or a complete lack of it led to the extinction of salmon in Polish waters. The last population of salmon in the Drawa River disappeared in the mid-1980s. The aim of this work was to re-establish salmon in Polish waters. The salmon for this purpose came from the Daugava River, when in 1985 and 1987, 50 000 and 30 000, eyed salmon eggs were bought, respectively. Up to 1996, salmon spawners were in the floating reared net cages in of the Puck Bay. Since 1994, spawns of salmon have been reared in freshwater at the fish farm "Aquamar" at Miastko. Stocking of smolt started in 1994 and by the year 2001, 2 238 653 one- and two-year-old smolts had been released. Smolts were released into rivers in the Pomeranian region, the Drawa, and the Vistula and its tributaries. Between 1994 and 2000, 77912 one- and two-year-old tagged smolts were released together with untagged ones. The first salmon in the Vistula and Drwęca rivers were noted in 1996. From 1997 to 2000, salmon catches in rivers fluctuated between 413 and 9714 kg. From 1997 salmon spawners were captured for artificial spawning. The largest spawners were 120-cm long and weighed 17.5 kg. Alongside untagged spawners, single tagged salmon were also used for spawning purposes. In 1997, a total of 382 000 eggs were obtained. In later years the number of spawns obtained grew, and in 2000 the number of eggs collected was 2 260 000. In 1996, spawns from salmon raised in pools at Świerzenko were collected. In 2000, there were 1168 females (length 30 - 70 cm) from which 9 300 000 eggs were collected. From 1997, large nests were observed at the spawning grounds in the Drawa River. In next years salmon nests were observed in the Drawa River and also in Parsęta and Wieprza rivers.

Percentages of recovers from tagged salmon were very low and varied from zero to 7.35.

Tagged salmon migrated all over the Baltic Sea. The most often they were caught in the Gulf of Gdańskarea, near Bornholm Island and in the western part of the Gulf of Finland. Salmon entered rivers mainly into Vistula, Drwęca and Wieprza rivers for spawning purposes. Some spawners strayed and entered rivers to which they were not released as smolt. Higher percentage of homing were observed among smolt into Vistula i Drwęca rivers than among smolt released into Pomeranian rivers. Tagged salmon after the firs year reached average length of 59.4 cm and average weight of 2583 g, after the second year 81.8 and 6255 g, after the third year 102.4 cm and 11800 g respectively.

Key words: salmon, smolts, re-establish, spawn, tagging, migration, growth

**Hydroacoustics as a tool for studying
the impact of habitat modification (degradation) upon fish: a review.**

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Abstract:

Hydroacoustical methods due to their very high resolution in time and space can be used to register subtle changes in fish distribution and behaviour, thus enabling observation of the effect of habitat modification upon the fish. A number of examples have been presented which show dependence between fish parameters measured acoustically (such as depth, density, degree of aggregation, length frequency distribution), and different environmental parameters characterising the habitat quality (trophic levels, presence of chemicals, littoral coverage, predation pressure, temperature and oxygen gradients). This suggest that by performing hydroacoustical monitoring one can measure fish reactions to the habitat changes on a scale and with an accuracy not available with other methods.

Key words: fish density, fish distribution, habitat quality, dammed reservoir

Hydrological Importance of Carp Ponds in the Upper Vistula River Catchment Basin

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Abstract

Apart from their basic role as fish farming reservoirs, carp ponds have an important influence on water circulation and thus on water resources in the catchment basin. The positive influence of carp ponds as storage reservoirs results from the rearing cycle which corresponds with the hydrological cycle and consists in limiting high water-flows in the summer and increasing low water-flows in the autumn. After the maximum precipitation shifted in the late 1960s from summer months to autumn months, a dramatically low water level occurred in the summer. This highly disturbed the catchment basins' hydrological balance as well as the ponds' water management. The influence of the changing meteorological conditions on individual components of the water balance are presented as a result of many years' research (1957-1997) conducted at the Institute of Ichthyobiology and Aquaculture of the Polish Academy of Sciences in Gołysz.

Key words: water circulation, rearing season, precipitation, evaporation, water-flow, small retention.